VICI

Valco Instruments Co. Inc.

Multiposition Electric Actuator Instruction Manual

GENERAL DESCRIPTION **1**

MANUAL USE OF THE MULTIPOSITION VALVE ACTUATOR **2**

CONTROLLING THE ACTUATOR WITH A COMPUTER **3**
- STEP and HOME Commands
- Random Access with BCD Logic

ACTUATOR MODIFICATIONS **7**
- Changing the Number of Positions (Indexing Angle)
- Reversing the Direction of Rotation

VALVE ALIGNMENT **12**
- Causes of Misalignment
- Chromatographic Symptoms of Misalignment
- Alignment Procedure

TECHNICAL DRAWINGS **17**

WARRANTY **30**

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General Description

Valco multiposition valves are used to select a flow from a number of different streams in gas and liquid chromatography and in process stream applications. Switching them to the desired position can be done manually, but is best done automatically with either a Valco multiposition air actuator or the random access Valco multiposition electric actuator described in this manual. For most laboratory uses, especially where a laboratory computer is available for control but compressed air is not, the Valco multiposition electric actuator is the best choice for switching multiposition valves.

The Valco multiposition electric actuator is designed around a highly-integrated microcontroller, and is capable of detecting the number of valve positions for which it is configured as well as a number of faults. Actuators are available in 110 VAC or 220 VAC models for any 4, 6, 8, 10, 12, or 16 position Valco multiposition valve. The model numbers of the actuators are respectively E4, E6, E8, E10, E12, and E16. (Or E4-220, etc.) An electric actuator can replace an existing air actuator, and is compatible with most Valco close mount and standoff assembly hardware.

The actuator consists of (a) the actuator itself, (b) a control box with LED display, and (c) a 20 conductor interface cable. An actuator typically takes four seconds to complete 360°; that is, a 4 position valve takes one second to move the 90° from Position 1 to Position 2.

A computer or data system with external event capacity can be used to control the actuator using the supplied interface cable. In such a quickly developing field it would be futile to try to give specifics for each possible application, but the chapter entitled “Controlling the Actuator with a Computer” on page 3 provides some general instructions which will be sufficient for most situations. Consult the factory if additional help is needed.

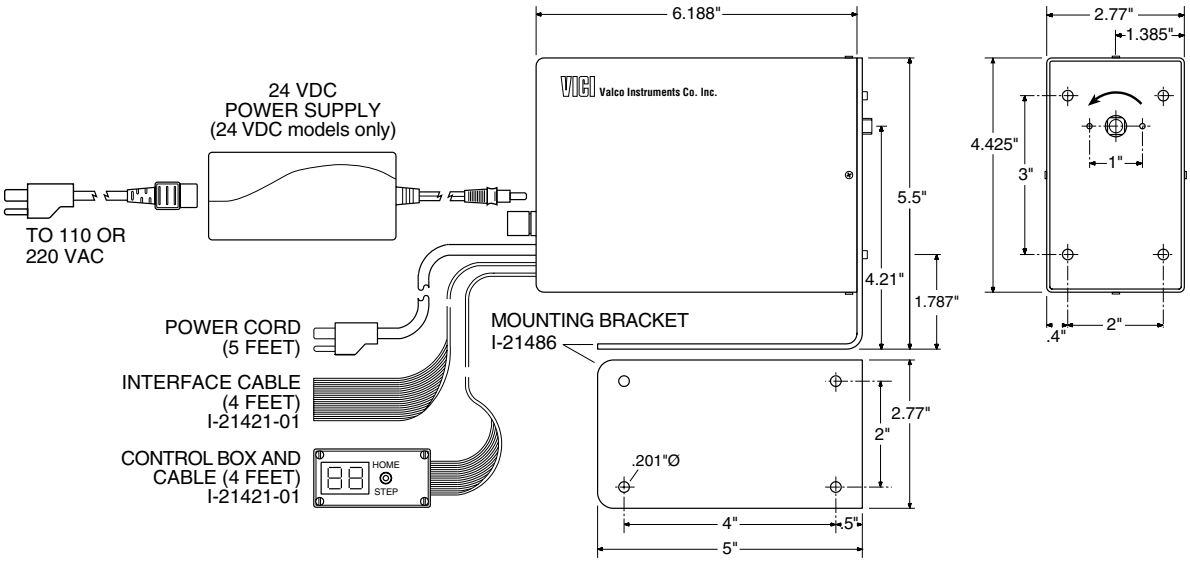
Manual Use of the Multiposition Valve Actuator

1. Plug the electric actuator into a power outlet (110 VAC or 220 VAC, 50/60Hz, as required). The LED indicator light in the control box (**Figure 1**) will light up and indicate the position of the valve/actuator.

2. Press the control box toggle switch momentarily toward HOME. If the valve is in any position other than Position 1, it will go to HOME (Position 1). If the valve is in Position 1, it will not move.

   As the valve moves toward HOME it sequences through each position, allowing the possibility that sample may flow briefly as each position is made. Care must be taken to prevent possible sample loss or contamination.

3. Move the toggle switch momentarily toward STEP and the valve will advance from Position 1 to Position 2. If the switch is moved toward STEP again, the valve will move from Position 2 to Position 3.



Controlling the Actuator with a Computer

The first step in interfacing the Valco multiposition electric actuator to a computer or data system is to consult the user's manual of the control device to determine what kind of outputs are available, and how many there are. There may be relays, open collector transistors, logic level signal outputs, or an RS-232 connector. (These are not cleanly delineated categories; for instance, BCD logic will involve one of the others.)

The second step is to determine how the valve is to be moved. The simplest implementation is for the control device to duplicate the STEP and HOME commands of the manual controller. The other option is to access the positions randomly via BCD-encoded logic level signals. In this mode, the actuator passes through each intermediate position, stopping when it reaches the encoded position. In either case, as the valve sequences through each position it is possible that sample may flow briefly as each position is made.

STEP and HOME Commands

Look at Drawing 21464, page 18, to determine the functions of the different wires in the interface cable. All of the inputs are held at five volts, called a "logic high". When they contact ground, the voltage drop signals the logic circuits in the actuator to direct the motor to the appropriate point.

Locate the violet wire for HOME, the grey wire for STEP, and the white wire for GROUND. After stripping a small amount of insulation from each of the wires, touch the grey wire to the white wire and observe that the actuator advances one position. Touching the violet wire to the white wire causes the actuator to rotate all the way around to Position 1, or HOME. (If the actuator is already in Position 1, nothing happens.) The contact must be maintained for at least 0.2 seconds to be recognized as valid.

These steps demonstrate the goal; that is, getting the control device to emulate the action of touching the two wires together. Nothing else, such as applying a voltage to one of the wires, is involved. For relays or open collector transistors, which are essentially switches, connect the three wires to the proper terminals as indicated by the manual for the control device. (**Figures 2** and **3**)

NOTE: A poor quality relay may cause the unit to step multiple times, due to the relay's excessive contact bounce. If contact bounce lasts longer than 50 ms, the actuator will see this as repeated STEP commands.

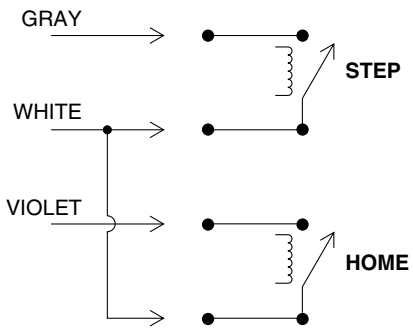


Figure 2: Relay connections

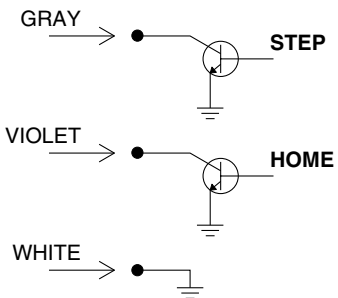


Figure 3: Open collector transistor connections

Random Access

Logic Input

For devices with an RS-232 connector, a simple solution is available in the form of the Valco Serial Valve Interface (SVI). The SVI is a self-contained unit, complete with software, that will convert commands from a computer into positional control for as many as two multiposition and four two position Valco electric actuators. Designing a similar means of control for a computer without a serial port requires a little more thought and effort on the part of the user.

Refer to Drawing 21464 on page 18 to determine the functions of the wires in the interface cable. All of the inputs are held at five volts, called “logic high”. When they are pulled to ground potential (“logic low”), the voltage drop signals the logic circuits in the actuator to direct the motor to the appropriate point. Randomly accessing the positions involves two steps: first, a logic low signal must be applied to the proper BCD input lines to tell the actuator which position to go to; then, a logic low signal must be applied to the enable line, telling the motor to turn on and find the specified position.

Locate the inputs which are labelled 1’s, 2’s, 4’s, 8’s, and 10’s, plus PRESET ENABLE and GROUND. Strip a small amount of insulation from each of these wires. To demonstrate the two steps described in the previous paragraph, first touch the brown wire (1’s) to the white wire (ground), loading the code for Position 1. Then, while the brown and white wires are still in contact, touch the green wire (PRESET ENABLE) to the white wire (ground) to execute the move to Position 1.

Position 2, 4, 8, and 10 are just as straightforward, but the other positions involve combinations of two or three wires. To load the code for Position 3, twist the 1’s and 2’s wires together and touch them to ground. For Position 5, twist together the 4’s and the 1’s. A complete table appears below.

Position	BCD Combination
1	1’s
2	2’s
3	1’s + 2’s
4	4’s
5	4’s + 1’s
6	4’s + 2’s
7	4’s + 2’s + 1’s
8	8’s
9	8’s + 1’s
10	10’s
11	10’s + 1’s
12	10’s + 2’s
13	10’s + 2’s + 1’s
14	10’s + 4’s
15	10’s + 4’s + 1’s
16	10’s + 4’s + 2’s

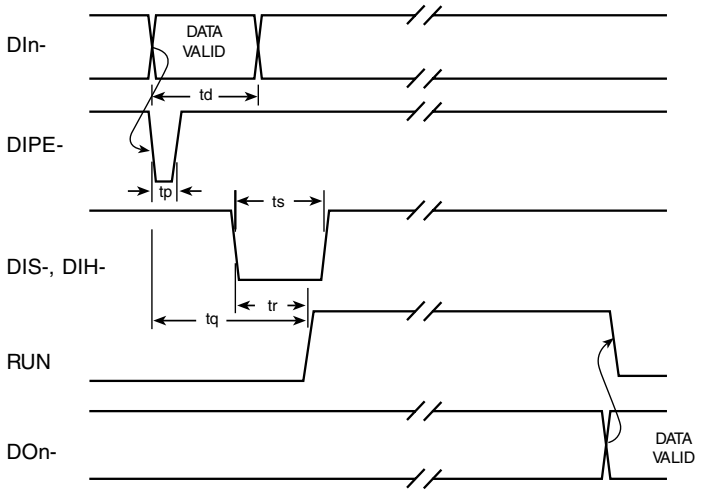


Figure 4: Input/Output Timing
(Not to scale)

To implement the BCD logic, attach the remote cable wires for the PRESET ENABLE, 1's, 2's, etc. to relays or transistor collectors. The white GROUND wire must go to a "common" point on the control device. (However, direct connection to open collector transistor outputs may not be suitable in all environments – the use of opto-isolators may be required. If in doubt, consult an electronics design expert.) Software must then be created which will control the appropriate inputs in accordance with the timing diagram shown in **Figure 4**. The direct BCD position inputs (DI1- for for BCD1's through DI10- for BCD10's) must be valid before the PRESET ENABLE pulse (DIPE-) goes low, and should remain valid for the period, *td* (1.6 milliseconds minimum), after DIPE- goes low. The enabling pulse, DIPE-, should remain low for the period, *tp* (5 microseconds minimum). When the STEP (DIS-) or HOME (DIH-) input is used, it must be held low for the period, *ts* (200 milliseconds minimum), to be recognized as valid. (STEP and HOME operation may be effected with pulses as short as 50 milliseconds, but it is not guaranteed.)

Logic Output

Some computers have actual BCD logic inputs and outputs, by which the combinations indicated in the table on the previous page are generated by the software. This allows a relatively straightforward setup, but matching the logic sense between the actuator and computer is critical. The input and output of the actuator are low-true, as supplied from the factory. If the computer to be used requires a positive true logic (consult the manual for the computer or interface board being used), the BCD output of the actuator may be reversed by following these steps to change one of the integrated circuits:

1. Unplug the actuator. Remove the four 4-40 x 1/4" phillips head screws which secure the cover to the actuator assembly, and remove the cover from the body of the actuator assembly.

2. Remove the four 4-40 x 1/4" phillips head screws from the rear cover, which allows the removal of the PC board inside the cover.

3. Refer to Drawing 22721 on page 19. Replacing integrated circuit U2 (a 4049) with a 4050 changes the output from negative true to positive true. (Order Valco Product No. I-IC4050.)

4. Reinstall the board in the cover and reassemble the actuator and cover, making sure that all the wires and cables are reconnected to the Encoder Board assembly.

When it is certain that the polarities of the actuator and the control device are compatible, connect the 1's wire of the actuator interface cable to the 1's output, the 2's wire of the cable to the 2's output, etc. If the timing restrictions for logic inputs are followed, timing of the logic outputs will also be in accordance with **Figure 4**. The signal, RUN, indicating actuation of the valve, will go high within the period, *tr* (200 milliseconds maximum), after DIS- or DIH-. RUN will remain high until the motor stops, and will then go low. Position data at the outputs, DO1- through DO10- will be valid before RUN returns low.

Error Signaling

Errors or faults detected by the actuator logic are signalled by the display flashing in a coded sequence which indicates the problem. The display will go off briefly once, twice, or three times, followed by a pause before the cycle repeats.

1: Indicates a fatal internal failure of the microcontroller.

2: BCD position input is invalid; *i.e.*, the position requested cannot be found on the encoder disk. Clear by entering STEP or HOME, or a valid position.

3: Indicates motor failure, overheating, or excessive load on the actuator.

Actuator Modifications

Situations occasionally arise when it is desirable to alter an actuator so that the indexing angle is changed, such as when changing from a 6 position to an 8 position valve. Or it may be helpful when changing from air to electric actuation to reverse the rotation so that it will go the same direction as the air actuator. These modifications can be accomplished by following the procedures below.

CAUTION: Before performing any operations on the actuator, make sure the actuator power cord is unplugged.

Changing the Number of Positions (Indexing Angle)

Tools you will need:

1. 9/64 hex driver
2. 7/64 hex driver
3. #1 or #0 phillips screwdriver

You will also need one of the following, depending on the new valve type:

Product No.	Description
I-21536	4 position encoder disc
I-21537	6 position encoder disc
I-21538	8 position encoder disc
I-21539	10 position encoder disc
I-21540	12 position encoder disc
I-21541	16 position encoder disc
I-21543	4 x 2 encoder disc (4 column selection)
I-21542	6 x 2 encoder disc (6 column selection)
I-21978	10 x 2 encoder disc (10 column selection)

Disassembly

1. Switch the actuator to its HOME position and then unplug the power cord.

2. Remove the valve and its mounting hardware from the actuator.

   For a closemount valve: (Figure 5) Use the 7/64 hex driver to loosen the socket head screw (6-32 x 5/8") in the CR11 clamp ring between the valve and the actuator. This allows the valve to be taken off the actuator.

   For a valve on a standoff: (Figure 6) Use the 9/64 hex driver to loosen the socket head screw (8-32 x 5/8") in the black-anodized CR3 clamp ring on the actuator. Pull off the standoff with the valve attached.

3. Remove the four 4-40 x 1/4" phillips head screws which secure the actuator cover. (One is accessed through the hole in the black right-angle mounting bracket.) Slide the cover back far enough to allow the power cord and the ribbon cable to be disconnected from the circuit board. Carefully note how they are attached so that they can be reconnected later. Now remove the cover completely.

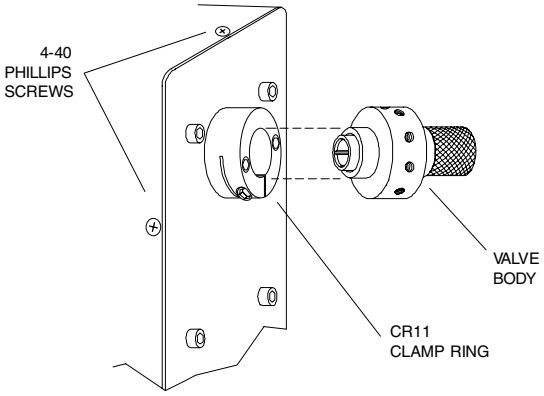


Figure 5: Closemount assembly connecting actuator and valve

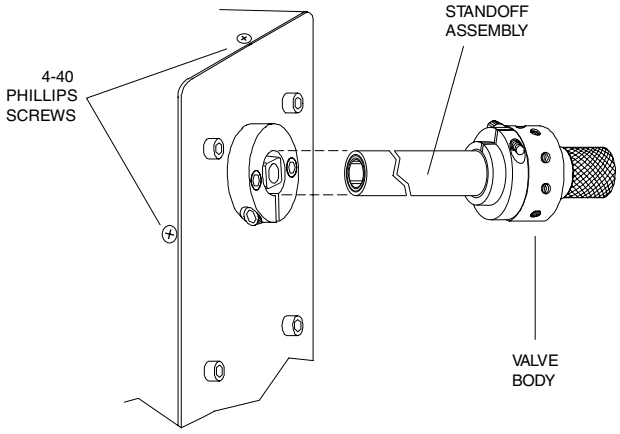


Figure 6: Standoff assembly connecting actuator and valve

4. Disconnect the motor from the board. (Refer to Drawing No. 22835 on page 29.)

5. Loosen but do not remove the two 8-32 x 1-1/4" hex head (9/64) screws which hold the boards to the gearbox. Remove the board/spacer assembly as a unit, lifting it straight up to clear the thin metal encoder disc.

6. Removing the boards exposes the encoder disc, which is the component that must be changed. Use the 9/64 hex driver to remove the screw and washer which secure the disc, and then remove the disc, avoiding its sharp edges. Handle the disc gently so it does not get bent.

Description of the Encoder Discs

The encoder disc provides a means of signalling the position of the actuator and relaying that information to the logic circuit. If the disc is thought of as consisting of five concentric bands, (like an archery target) the outside band contains the “strobe bits.” (See **Figure 7**) These slots signal the logic circuit to read the position information and to stop the motor when the information conforms to the input command. The next bands, in order toward the center, denote units of one, two, four, and eight.

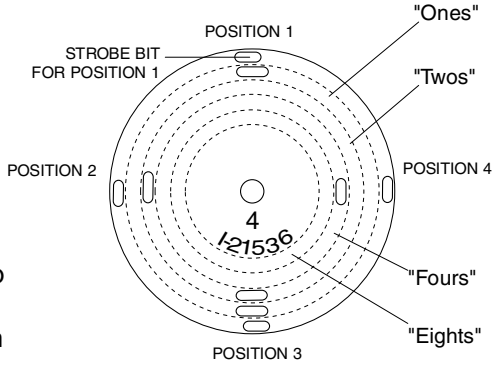


Figure 7: Four position encoder disc

In the 4-position disc illustrated in **Figure 7**, the location that corresponds to the strobe bit for Position 1 contains only a slot in the “ones” band, so it registers as “one”. Moving counterclockwise to the next strobe bit, the slot is in the “twos” band and is read as “two” for Position 2. Since there is no “threes” band, the information for Position 3 requires a slot which fills the “ones” band and the “twos” band, registering as 2 + 1, or 3. Position 4 has simply the one slot in the “fours” band. The 4-position disc affords the clearest illustration of the principles involved, which are the same all the way up to the 16-position. To continue the examples, Position 5 has slots in “fours” and “ones”, Position 9 has slots in “eights” and “ones”, and Position 15 uses the whole range, 8 + 4 + 2 + 1. The last position location on a 16-position disc utilizes the last option – no slots at all.

The 4 x 2, 6 x 2, and 10 x 2 are slightly different. The 4 x 2 is essentially an 8-position actuator, but instead of reading out Position 1 through Position 8 it goes from Position 1 to Position 4 and then repeats the succession. Likewise, the 6 x 2 does two sequences of Positions 1 through 6 and the 10 x 2 does two sequences of Positions 1 through 10.

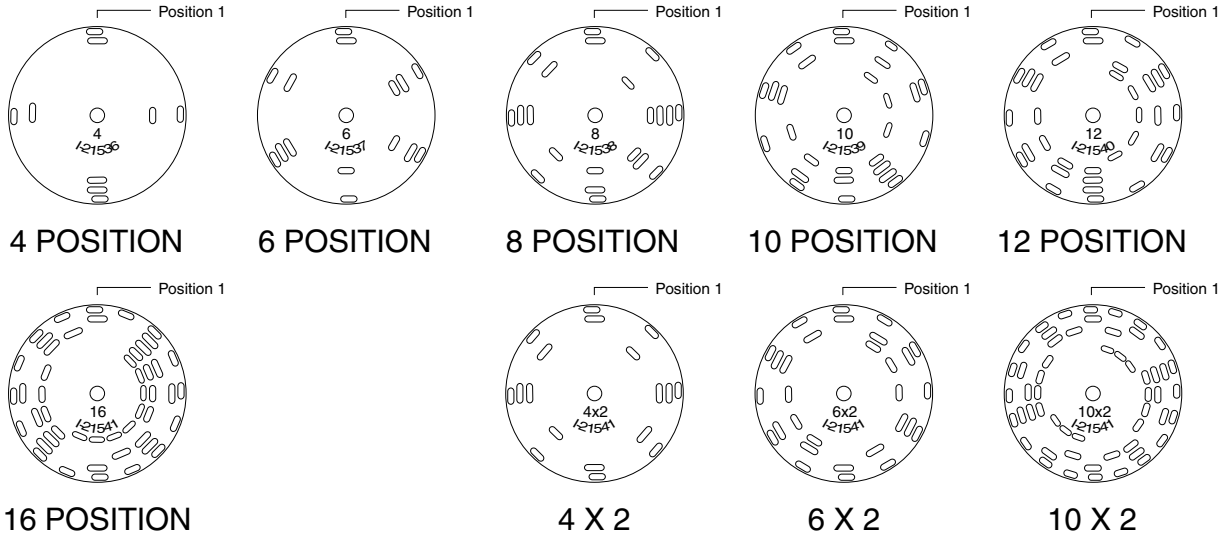


Figure 8: Encoder discs

Reassembly

1. Using **Figure 8** and the preceding description, identify the slot on the replacement encoder disc which determines Position 1. With the motor toward you and the casting away, install the new encoder disc oriented as in **Figure 8**, with the strobe bit of Position 1 vertical. (The part number should be facing you. In the case of the “x 2’s”, either Position 1 bit may be vertical.) Be sure to use the correct number of washers between the disc and shaft, so that the disc is positioned midway between the emitter and the encoder boards.

2. Position the circuit board assembly and reinstall it with the two 8-32 x 3/4” screws.

NOTE: If the assembly has come apart, make sure the spacers are in the proper arrangement: The two shorter spacers go between the assembly and the gearbox. Also check at this point to make sure that the disc is not bent in such a way that it will come into contact with the board as it revolves.

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3. Change the label on the cover to reflect the new number of positions. Put the cover partially on and reconnect the ribbon and power cables to the board in the motor assembly. It is necessary that they cross inside the cover.

4. Hold the ribbon and power cables out of the way against the transformer as the cover is repositioned over the motor assembly. Put in the four 4/40 x 1/4" phillips head screws which hold the cover in place.

5. Plug in the actuator and step it through all its positions to see that it works properly.

6. Consult the section entitled “Alignment Procedure” on page 13 for help in properly installing and aligning the new valve on the actuator.

Consult the factory if additional help is needed.

Reversing the Direction of Rotation

Tools you will need:
1. 9/64 hex driver
2. 7/64 hex driver
3. #1 or #0 phillips screwdriver

Disassembly

Follow the steps for disassembly on page 7. However, before removing the encoder disc as described in Step 6, use a felt pen to mark the point on its radius that is at 12 o’clock. If Step 1 was observed and the actuator was switched to HOME, this will be at the notch (strobe bit) that denotes Position 1.

Reassembly

1 Reinstall the encoder disc with the same point at 12 o'clock but with its opposite face out. If there is any question about the orientation of the disc, refer to **Figure 8**. But remember that once Position 1 has been located according to that illustration, the disc must be flipped over (on an axis from 12 o'clock to 6 o'clock, so that the opposite face is out) to function properly when the direction of the motor is reversed.

2. Locate the three leads (yellow, gray, and black) that form the connection from the motor to the circuit board. Looking at the connector, observe the three small metal tines, one for each wire. Depressing the high point of the tine with a ball point pen or something similar will allow the wire to be extracted from the connector. See **Figure 9**. Reverse the positions of the yellow and gray wires, making sure the wires are pushed back in far enough to fully engage the tines.

3. Follow the steps for reassembly in the previous section.

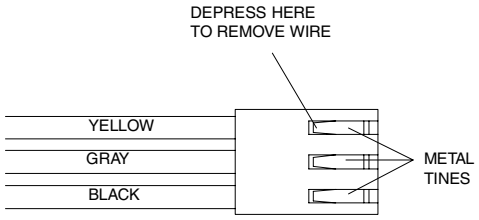


Figure 9: Motor connector

Valve Alignment

When the valve arrives from the factory installed on an actuator, it is accurately aligned and ready for use. However anytime the clamp ring on the actuator is loosened, as when removing the valve from the actuator for mounting through an instrument panel or oven wall, the valve and actuator must be realigned so that the internal ports and flow passages on the rotor intersect properly.

CAUTION: Before removing the valve from the actuator, mark the factory alignment position of the valve.

CLOSEMOUNT: Make temporary registration marks on the face of the valve where it lines up with the slot in the stainless clamp ring on the actuator.

STANDOFF: Make temporary registration marks on the standoff tube where it lines up with the slot in the black anodized clamp ring on the actuator. Do not remove the valve from the standoff assembly.

When this mark is lined up with the slot on reassembly, the factory alignment will be approximately reproduced as long as the valve and the actuator remain in their original positions.

Causes of Misalignment

1. Removal of valve from actuator for mounting

As referred to earlier, mounting valves through a bracket or oven wall requires that the valve or valve/standoff assembly be separated from the actuator. In the case of a valve on a standoff, this is accomplished by loosening the socket head screw (8-32 x 5/8") in the black anodized CR3 clamp ring on the actuator, using a 9/64 hex driver. (**Figure 6**) In valves utilizing a closemount assembly, the removal is accomplished by using a 7/64 hex driver to loosen the socket head screw (6-32 x 5/8") in the stainless CR11 clamp ring on the actuator. (**Figure 5**)

Any time the screw in the CR3 or CR11 clamp ring has been loosened, the alignment of the valve after replacement on the actuator should be checked. The chances of proper alignment after reassembly are greatly enhanced by following the suggestion in the highlighted note found in the box above.

CAUTION: In some applications it is desirable to delete the black right-angle mounting bracket supplied as part of the actuator, as when it is replaced by an oven wall or instrument panel. For the valve mounting and driving hardware to function properly, the thickness of the substitute must approximate the thickness of the bracket. Consult the factory if problems are experienced.

2. Shock from heavy or continuous use

Occasionally, when valves are used in applications requiring a high-duty cycle, wear or shock can cause the screw and clamp ring to loosen. Instrument vibration may have the same effect. This allows the standoff to move, causing inaccurate rotor rotation. The most obvious symptom is observable movement of the standoff, valve, or actuator, which normally do not move when the valve is actuated.

Chromatographic Symptoms of Misalignment

1. Loss of flow or blocked flow

When the valve body, rotor, and actuator are not in proper alignment, the ports do not completely intersect the flow passages on the rotor. In the worst case there is no flow in any position, but slight misalignment may eliminate flow from ports on one side of the valve only. With a rotometer or a line placed into liquid, gas flow may be observed between positions as the actuator cycles the valve. In liquid applications, blocked flow may cause pump shutdown or failure of other components due to pressure buildup.

2. Mixing of samples

In some configurations with large ports and their corresponding large flow passages which are very close together, poor alignment can cause mixing of samples even when a flow restriction has not been observed. This may be manifested as “ghost” peaks or poor reproducibility.

Alignment Procedure

NOTE: The alignment procedures for air actuated and electrically actuated valves are not the same. For an air actuated valve, see Technical Note 707, Operation Notes and Alignment Instructions, Air Actuated Multiposition Valves.

Description

The valve will have either one (SD and SC types) or two (SF and ST types) rows of ports evenly spaced around the circumference of the body. See **Figure 10**. In addition there will be one (SD and SF types) or two (SC and ST types) “common” ports offset to either side of these rows. By convention, Position 1 falls counterclockwise from these common port(s) when the valve is viewed from the end away from the actuator. The rotor will have either one or two flow passages appearing as engraved rings around the seal, which intersect the common port(s). Flow passages perpendicular to the ring(s) connect the ring(s) to the selected port(s).

STUW

The only configuration which does not fall within this description is the STUW. Unlike the standard ST, these have one row of ports around the circumference, with two common ports offset in the same direction. The common ports are 180° apart, so only one shows in **Figure 10**. Special instructions and descriptions regarding STUW’s will be highlighted in this manner at several points in the procedures which follow.

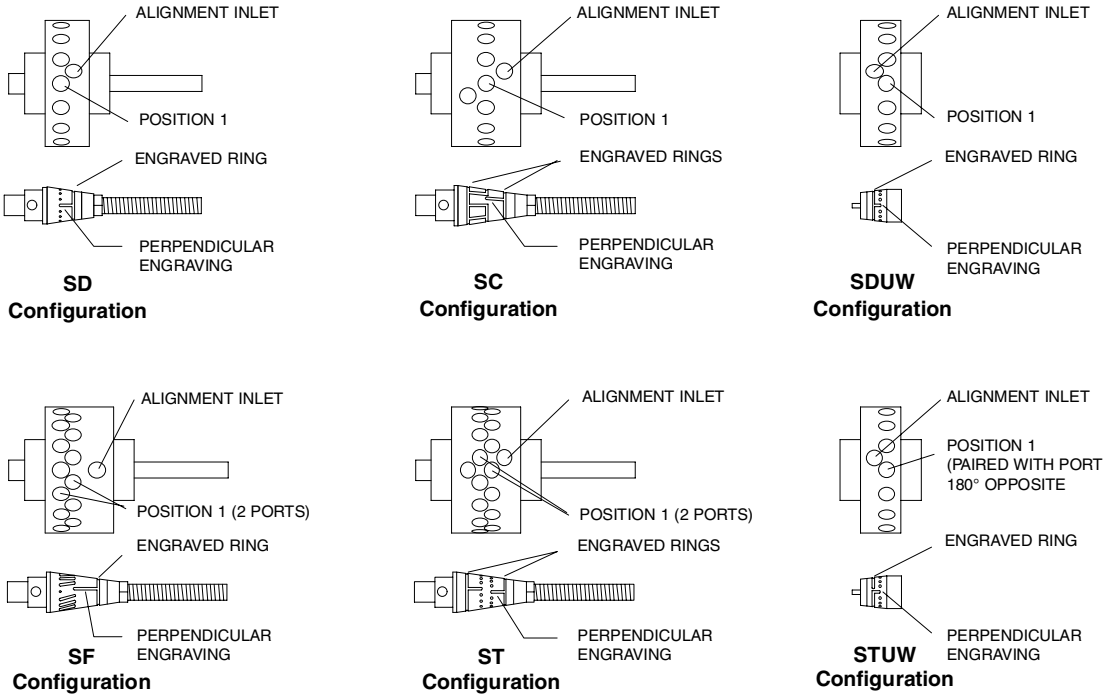


Figure 10: Typical multiposition valve bodies and seals

Basically, this procedure is a method of centering the perpendicular engraving on the selected port by determining the point at which flow begins (when the engraving just starts to intersect the port) and the point at which flow ends (when the engraving ceases to intersect the port), and centering the rotor between those two points.

1. Plug the actuator in. If the position indicator doesn't read "1", flip the switch to the HOME position.

2. Place the valve or valve and standoff combination on the actuator. By convention, the factory alignment places the common port(s) at 12 o'clock. Re-orienting the standoff or the slotted coupling (in closemount applications) on the square drive of the actuator allows three other possibilities.

   For a valve on a standoff, make sure the standoff butts all the way against the actuator so that the drive mechanism is completely engaged. Tighten the clamp ring screw enough to keep the standoff from falling out when it is released, but make sure it is loose enough to allow the assembly to be turned during the alignment procedure.

   For a closemount valve, make sure that the ends of the pin in the rotor are engaged by the slots of the coupling. Tighten the clamp ring screw enough to keep the valve from falling out when it is released, but make sure it is loose enough for the valve to be turned during the alignment procedure.

3. Establish a flow of clean gas (50 psi is adequate) into the port offset away from the actuator. This port, called the alignment inlet in **Figure 10**, will be the designated inlet throughout this procedure.

   STUW

   Establish gas flow into the common port at 6 o'clock (alignment inlet in **Figure 10**).

4. With the valve facing you and the actuator behind the valve, the port to the left of or counterclockwise from the alignment inlet corresponds to Position 1. (See **Figure 10**. This is the opposite of valves on air actuators.)

   STUW

   With the common port at 6 o'clock as the alignment inlet, the port to the left of or counterclockwise from the common port at 12 o'clock corresponds to Position 1.

   If the gas is flowing from the port in Position 1, go to Step 5. If you hear no flow, grip the valve and rotate it either way as necessary (the actuator keeps the rotor fixed) until gas flows from this port.

NOTE: When listening for flow, it is helpful if the fittings are removed from the port under consideration but left in the adjacent ports. If all the fittings have been removed, install a loop connecting the two adjacent ports to better isolate the sound of the flow.

5. Grip the valve and rotate it counterclockwise a few degrees past the point where flow stops.

   This sets up a "staging area" for the approach to Position 1.

6. Grip the valve and slowly rotate it clockwise until the first traces of flow are heard from the port of Position 1. (The port to the left of the alignment inlet.)

7. While holding the valve steady, use a soft pencil or ink marker to make a mark on the standoff corresponding to the slot in the actuator clamp ring. This slot makes a clear fixed reference point for observing relative rotational positions. In the case of a closemount valve, make this mark on the valve body. (**Figure 11**)

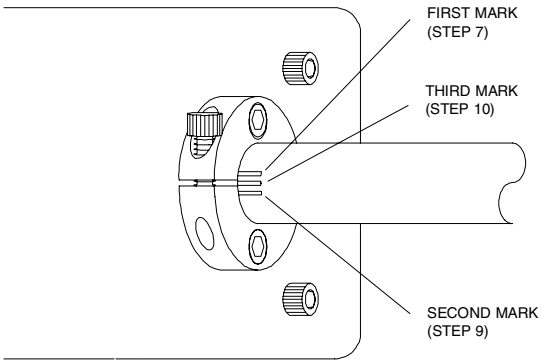


Figure 11: Marking valve or standoff during alignment procedure

8. Continue the slow manual clockwise rotation of the valve body through the point of peak flow and beyond until the flow stops or is barely perceptible, as in Step 6.

9. Make another mark as in Step 7. (**Figure 11**)

10. Make a third pencil mark halfway between the first two and rotate the valve counterclockwise until this midway mark is reached. (**Figure 11**)

11. While holding the valve steady, firmly tighten the screw in the clamp ring. The rotor should be properly positioned at the point of maximum flow when the actuator is stepped to the next position.

Congratulations, the procedure is complete. It is a good idea to cycle the valve through all its positions to be certain everything is functioning properly. In some cases it is possible to do an additional check by simply looking down the fitting detail and into the port as the valve is stepped from position to position. If it is a valve which has a relatively short distance from the bottom of the detail to the internal taper, the engraved “dimples” on the seal are visible as they come into alignment with the port.

Consult the factory if additional help is needed.

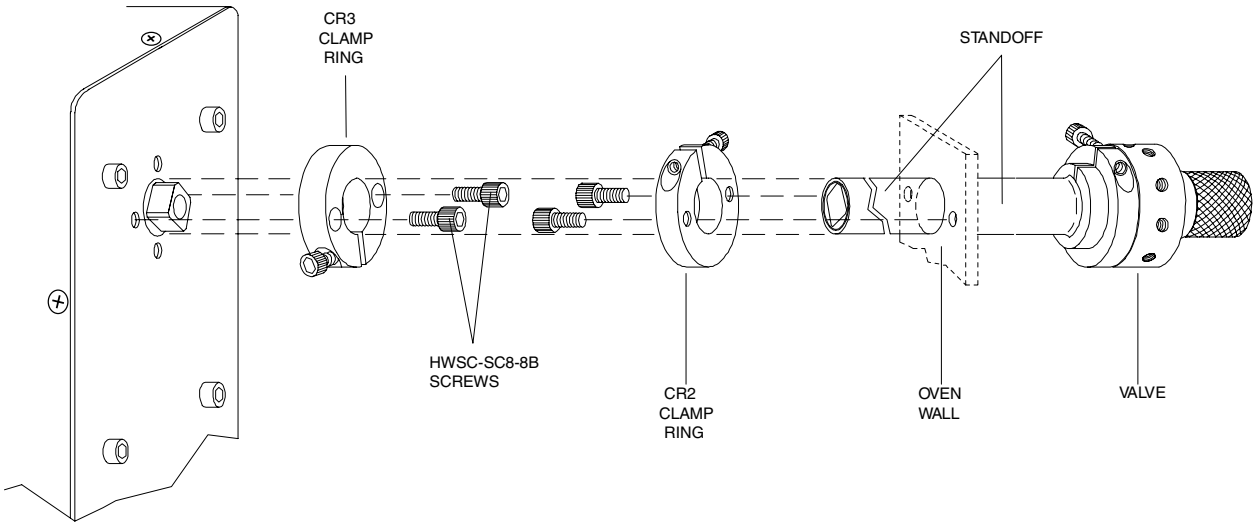


Figure 12: Standoff assembly connecting actuator and valve

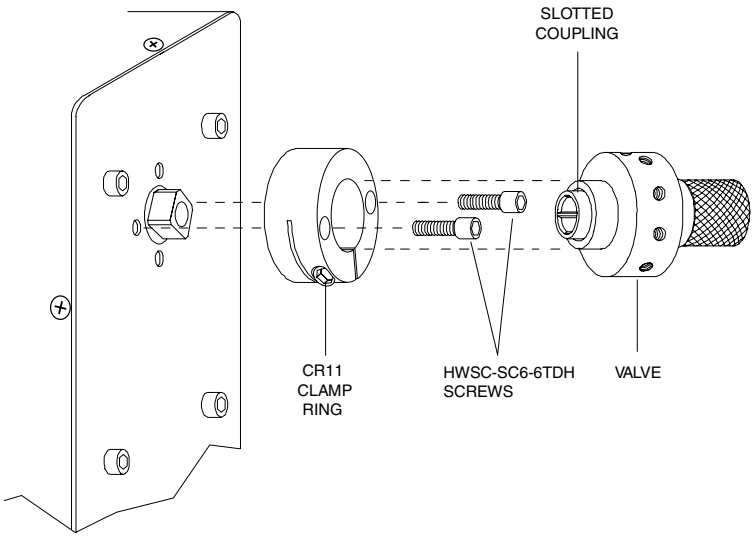
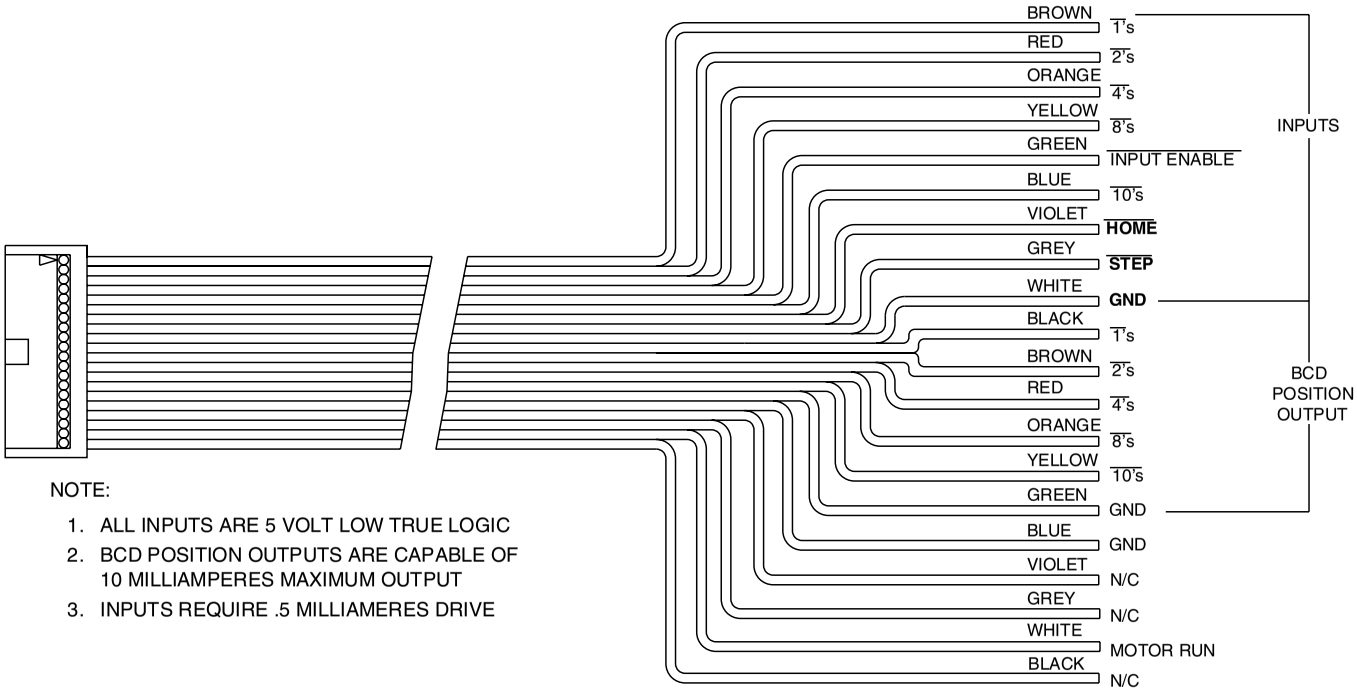


Figure 13: Closemount assembly connecting actuator and valve

Technical Drawings

Interface Cable Assembly	Drawing 21464	Page 18
Logic Board Schematic	Drawing 22721	Page 19
Logic Board Assembly	Drawing 22720	Page 20
Controller Assembly	Drawing 21412	Page 21
Encoder Board Schematic	Drawing 22727	Page 22
Encoder Board Assembly	Drawing 22726	Page 23
Driver Board Schematic	Drawing 22724	Page 24
Driver Board Assembly	Drawing 22723	Page 25
Transformer Board Assembly	Drawing 22729	Page 26
Transformer Board Schematic	Drawing 22730	Page 27
Multiposition Electric Actuator Assembly	Drawing 22835	Page 28
Multiposition Electric Actuator Motor Assembly	Drawing 22834	Page 29

REVISIONS			
LTR	DESCRIPTION	DATE	INITIATED
A	ECN #2147 UPDATE TO CURRENT STD'S	3OCT94 J DURR	



NOTE:

1. ALL INPUTS ARE 5 VOLT LOW TRUE LOGIC
2. BCD POSITION OUTPUTS ARE CAPABLE OF 10 MILLIAMPERES MAXIMUM OUTPUT
3. INPUTS REQUIRE .5 MILLIAMERES DRIVE

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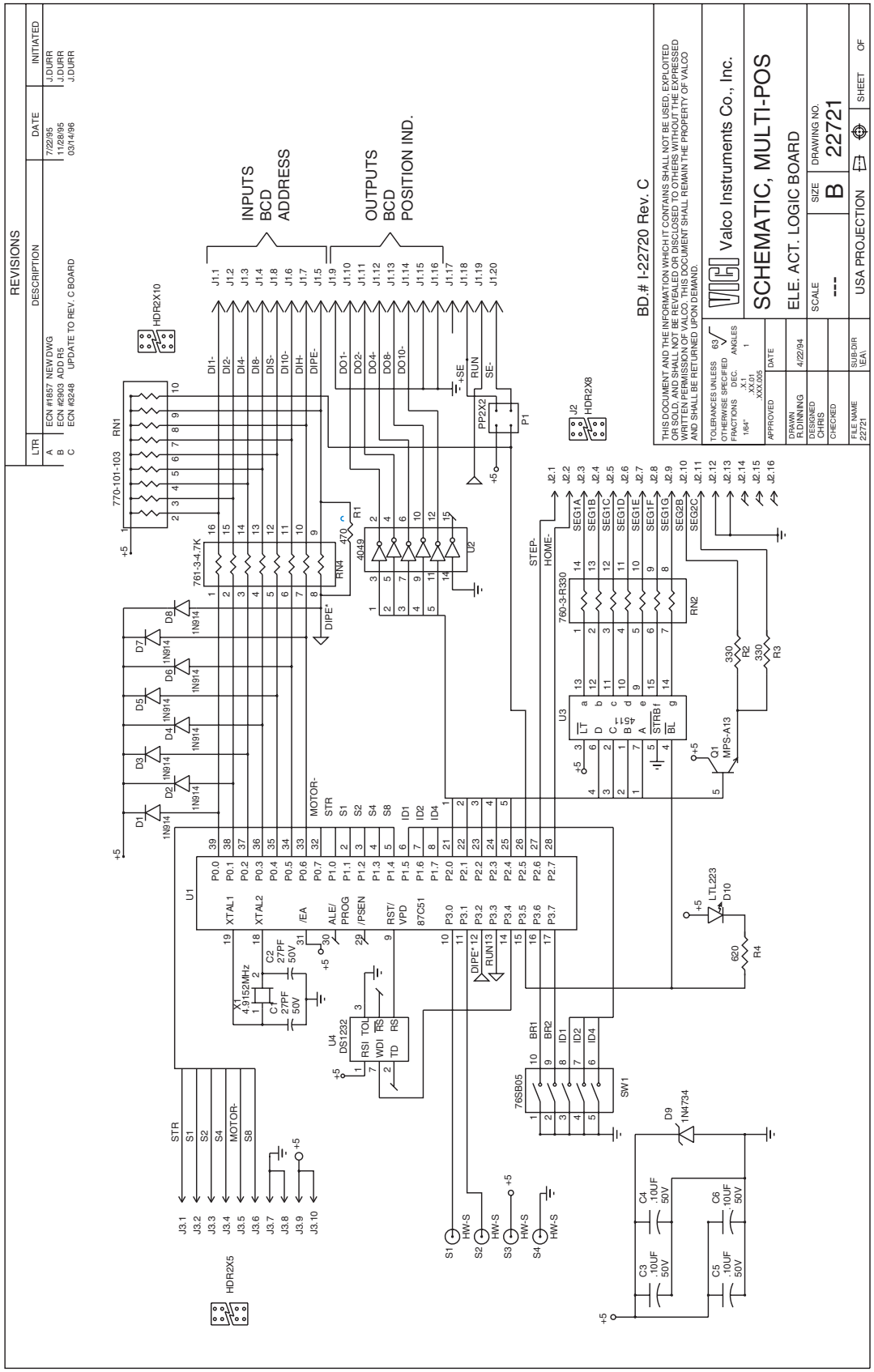
TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS 1/64" DEC. .X .1 .XX .01 .XXX .005 ANGLES 1 63			Valco Instruments Co., Inc.
			INTERFACE CABLE CONN.
APPROVED	DATE		MULTI POS. ELE. ACT. I-21464
DRAWN D.K.W.	1/2/91		
DESIGNED		SCALE ---	SIZE B / DRAWING NO. 21464
CHECKED			
NEXT ASSY B-21421,21575	FILE NAME 21464	SUB-DIR \EA\	USA PROJECTION / SHEET OF


REVISIONS
LTR DESCRIPTION DATE INITIATED
A ECN #1857 NEW DWG 7/22/95 J.DURR
B ECN #2903 ADD R5 11/28/95 J.DURR
C ECN #3248 UPDATE TO REV. C BOARD 03/14/96 J.DURR
INPUTS BCD ADDRESS
OUTPUTS BCD POSITION IND.
BD.# I-22720 Rev. C
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Valco Instruments Co., Inc.
SCHEMATIC, MULTI-POS
ELE. ACT. LOGIC BOARD
SIZE B
DRAWING NO. 22721
SCALE ---
USA PROJECTION
SHEET OF
FILE NAME 22721
SUB-DIR \EA\
APPROVED
DRAWN R.DINNING 4/22/94
DESIGNED CHRIS
CHECKED
U1
U2
U3
U4
RN1
RN2
RN4
SW1
P1
J2
X1 4.9152MHz
C1 27PF 50V
C2 27PF 50V
C3 .10UF 50V
C4 .10UF 50V
C5 .10UF 50V
C6 .10UF 50V
R1 470
R2 330
R3 330
R4 620
Q1 MPS-A13
D1 1N914
D2 1N914
D3 1N914
D4 1N914
D5 1N914
D6 1N914
D7 1N914
D8 1N914
D9 1N4734
D10 LTL223
761-3-4.7K
760-3-R330
770-101-103
4049
4511
DS1232
76SB05
HDR2X10
HDR2X8
HDR2X5
PP2X2
HW-S
+5
+SE
RUN
SE-
STEP-
HOME-
DIPE*
RUN13
MOTOR-
STR
S1
S2
S4
S8
ID1
ID2
ID4
BR1
BR2

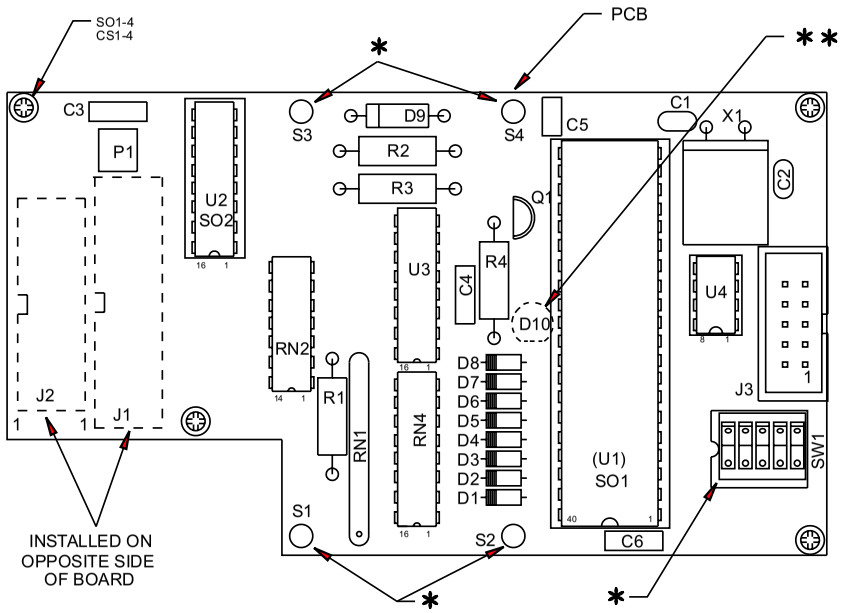
** = OPTIONAL

* = OPTIONAL FOR RS232

	DESCRIPTION		
ITEM	DESCRIPTION	VALCO #	QTY
PCB	PCB, LOGIC AW 330 (B) MULTI ACTUATOR	I-PCB22719	1
C1,2	CAP, CERAMIC, 27 PF 50V	I-CC270-50	2
C3-6	CAP, CERAMIC, .1uF 50V	I-CC104-50	4
D1-8	DIODE: SILICON SIGNAL	I-D1N914	8
D9	DIODE: 5.6V 1 WATT ZENER	I-D1N4734A	1
J1	HEADER 20 PIN STRAIGHT ANSLEY #6092027	I-T6092027	1
J2	HEADER 16 PIN PCB ANSLEY #6091627	I-T6091627	1
J3	HEADER 10 PIN STRAIGHT ANSLEY #6091027	I-T6091027	1
Q1	TRANSISTOR, NPN, T093, DARLINGTON	I-QMPSA13	1
R1	RES, 470, 5%, 1/4W	I-R514700	1
R2,3	RES, 330, 5%, 1/4W	I-R513300	2
R4	RES, 620, 5%, 1/4W	I-R516200	1
RN1	RES NET, 10 K, (256CK103X2PD)	I-RN256CK103	1
RN2	RES NET, 330, 14 PIN	I-RN760-3-330	1
RN4	RES NET, 4.7 K, 16 PIN	I-RN761-3-4.7K	1
SO1	SOCKET, DIP, 40 PIN, LOW PROFILE	I-TDS-40-LP	1
U2	IC: INVERTING HEX BUFFER	I-IC4049	1
SO2	SOCKET, DIP, 16 PIN, LOW PROFILE	I-TDS-16-LP	1
U3	IC, MCD-TO-7 SEG. LATCH/DECODER/DRIVER	I-IC4511	1
U4	MICRO-RESET CHIP W/WATCHDOG & PWR	I-ICCM1232	1
X1	CRYSTAL MCP 18-0491 (4.9152 MHZ)	I-XTAL-1	1
* SW1	SWITCH, DIP, 5 POS, GRAYHILL	I-SW-76SB05	1
* S1-4	CONNECTOR JACK (450-3388-01-04)	HW-450-3388	4
** D10	LED, RED LTL-223	I-LED-223-LTL	1
REF	SCHEMATIC	22721	---

	ADDITONAL PARTS LIST FOR I-22720-01		
ITEM	DESCRIPTION	VALCO#	QTY.
U1	IC PROGRAMMED ELECT. ACT. MULTI. REV E	I-PD-EMAC51RE	1
SO1-4	STANDOFF, 4-40 X 1/2" ROUND THREADED	HWSO-2372	4
SC1-4	SCREW, PLMS: 4-40 X 1/4 LG PH,SS	HWSC-PL4-4	4

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	ECN #1857 NEW DWG	05/03/94	CHRIS
B	CHG EPROM TO REV. E	03/21/95	J DURR
C	ECN #2740 ADD CUT/JUMP NOTE	09/05/95	J DURR
D	ECN #2903 ADD R5	11/28/95	J DURR
E	ECN #3248 UPDATE PER REV. C BD.	03/14/96	J DURR



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FRACTIONS 1/64" DEC. .X .1 .XX .01 .XXX .005 ANGLES 1
63

Valco Instruments Co., Inc.

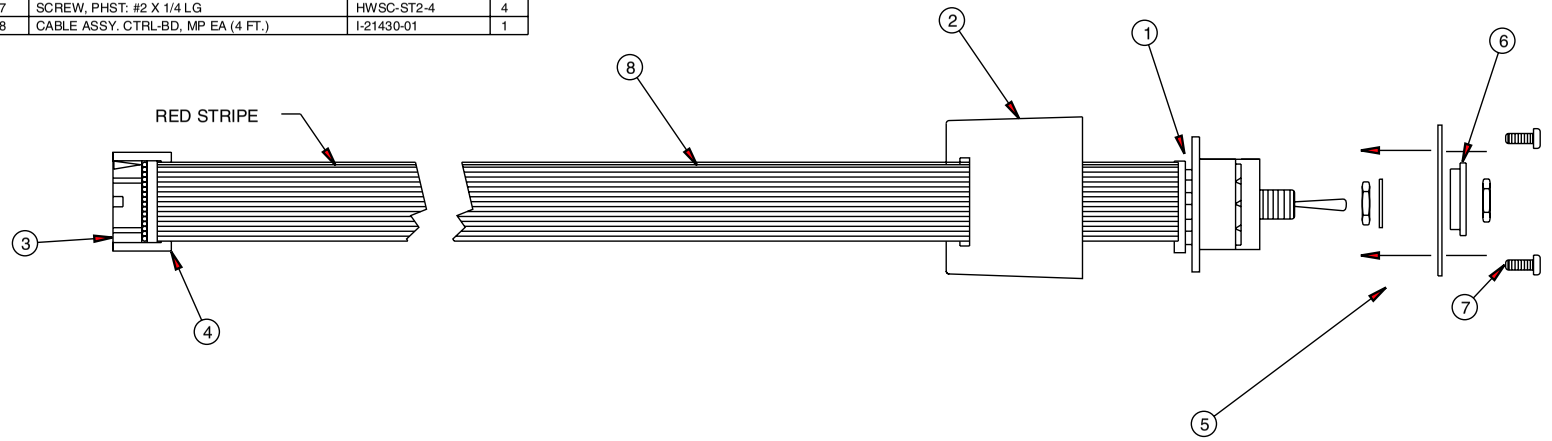
PCB ASSY, LOGIC

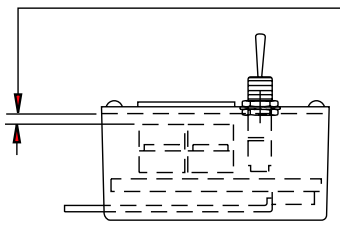
MULTI. POS. ELE. ACT. I-22720

APPROVED	DATE		
DRAWN R.DINNING	4/13/94	SCALE —	SIZE B
DESIGNED CHRIS		DRAWING NO. 22720	
CHECKED			
NEXT ASSY 22835	FILE NAME 22720	SUB-DIR \EA\	USA PROJECTION SHEET OF

PARTS LIST			
ITEM	DESCTIPTION	VALCO #	QTY
1	PCB ASSY., CONTROLLER, MP EA	I-21405-01	1
2	ENCLOSURE, MPEA CONTROLLER #2428	I-21418	1
3	CONN 16 PIN CABLE ANSLEY	I-T6091630	1
4	STRAIN RELIEF 16 PIN ANSLEY	I-T6091631	1
5	COVER, CONTROLLER ENCLOSURE MP EA	I-21458	1
6	LENSE, DISPLAY: RED	I-21119	1
7	SCREW, PHST: #2 X 1/4 LG	HWSC-ST2-4	4
8	CABLE ASSY. CTRL-BD, MP EA (4 FT.)	I-21430-01	1

REVISIONS			
LTR	DESCRIPTION	DATE	INITIATED
A	ADD NUTS AND WASHER TO DWG. (D.K.W.)	11/19/91	TVG
B	ECN #2147 UPDATE TO CURRENT STD'S	3OCT94	J DURR
C	ECN #3565 CORRECT LENS ASSY	02/4/97	J DURR
D	ECN #3905 SHOW STRAIN RELIEF	09/24/97	J DURR





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FRACTIONS 1/64" DEC. X.1 XX.01 XXX.005 ANGLES 1
63

Valco Instruments Co., Inc.

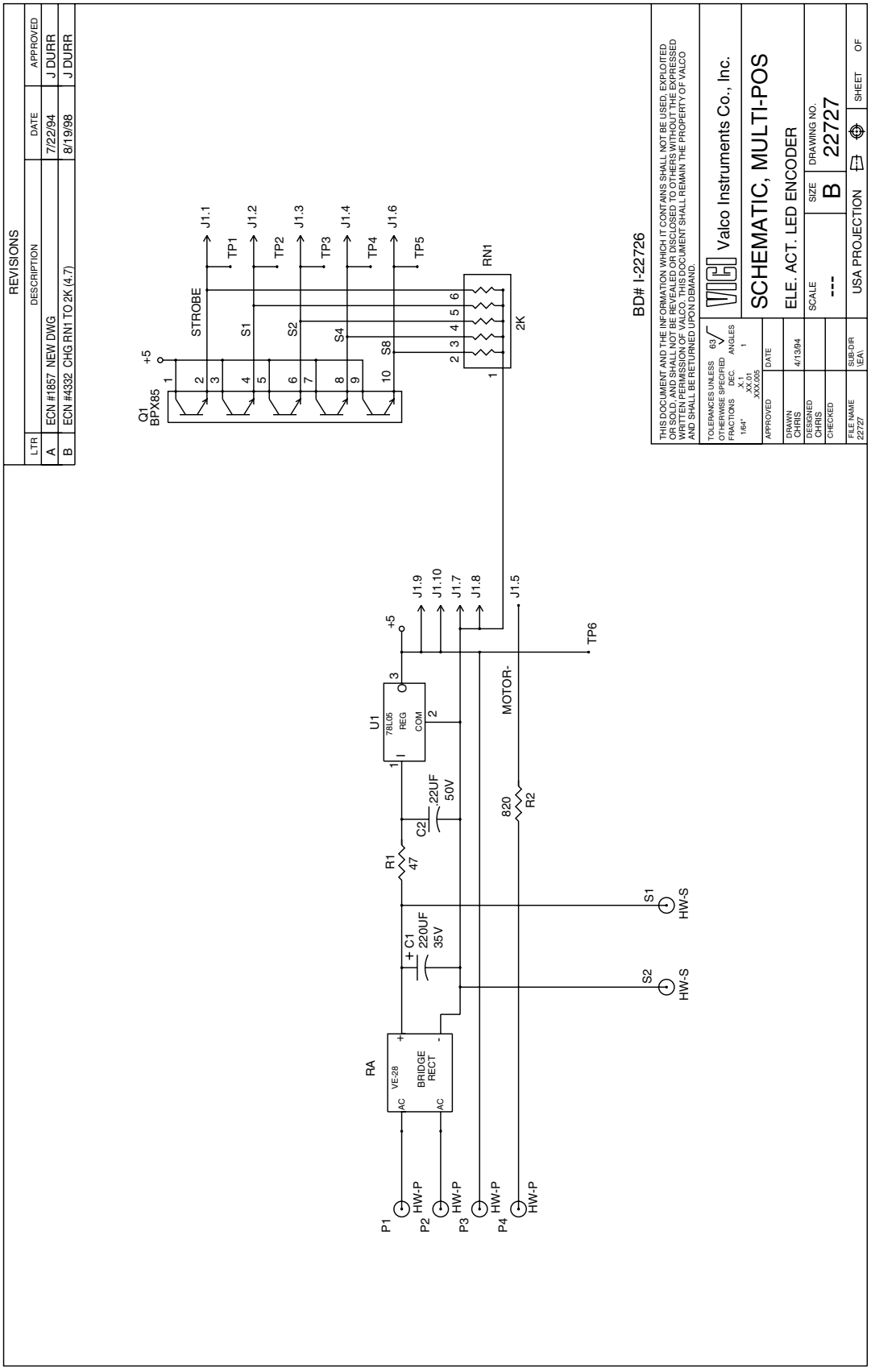
CONTROLLER ASSY

MULTI POS. ELECT. ACT. I-21412

APPROVED	DATE	
DRAWN D.K.W.	9/17/90	
DESIGNED		
CHECKED		
FILE NAME 21412	SUB-DIR \EA\	

SCALE —
SIZE B
DRAWING NO. 21412
USA PROJECTION
SHEET OF

NEXT ASSY. C-22835


REVISIONS
LTR
DESCRIPTION
DATE
APPROVED
A
ECN #1857 NEW DWG
7/22/94
J DURR
B
ECN #4332 CHG RN1 TO 2K (4.7)
8/19/98
J DURR
BD# I-22726
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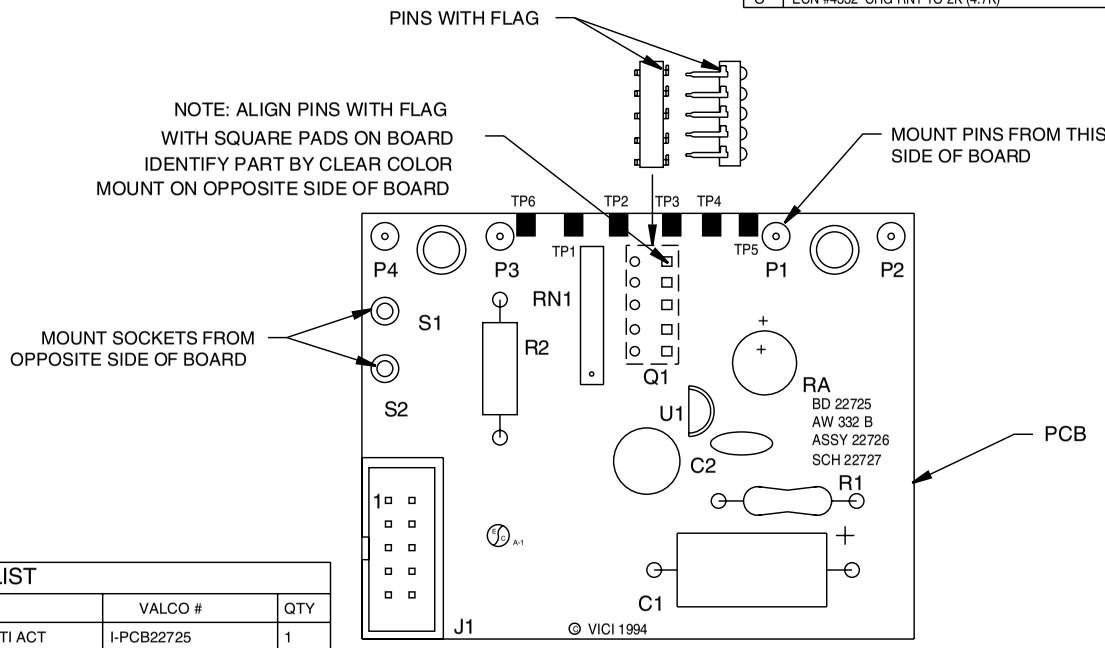
FRACTIONS 1/64"
DEC. X.1 XX.01 XX.005
ANGLES 1
63
APPROVED
DATE
DRAWN CHRIS 4/13/94
DESIGNED CHRIS
CHECKED
FILE NAME 22727
SUB-DIR \EA\
Valco Instruments Co., Inc.
SCHEMATIC, MULTI-POS
ELE. ACT. LED ENCODER
SCALE ---
SIZE B
DRAWING NO. 22727
USA PROJECTION
SHEET OF
Q1 BPX85
+5
STROBE
S1
S2
S4
S8
J1.1
J1.2
J1.3
J1.4
J1.6
TP1
TP2
TP3
TP4
TP5
RN1
2K
U1 78L05 REG
J1.9
J1.10
J1.7
J1.8
J1.5
TP6
MOTOR-
22UF 50V
C2
820
R2
R1 47
C1 220UF 35V
RA VE-28 BRIDGE RECT
AC
AC
+
-
P1 HW-P
P2 HW-P
P3 HW-P
P4 HW-P
S1 HW-S
S2 HW-S

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
B	ECN #1857 UPDATE TO REV B	5/4/94	CHRIS
C	ECN #4332 CHG RN1 TO 2K (4.7K)	8/19/98	J DURR



PARTS LIST

ITEM	DESCRIPTION	VALCO #	QTY
PCB	PCB, BOARD ENCODER AW 332 (B) MULTI ACT	I-PCB22725	1
C1	CAP, ELECT, 220uF 35V, AXIAL LEAD	I-CE227-35AL	1
C2	CAP, MONO CERAMIC, .22 uF 50V, .2"LEADS	I-CC224-50	1
J1	HEADER 10 PIN STRAIGHT ANSLEY #6091027	I-T6091027	1
Q1	PHOTOTRANSISTOR ARRAY, 5X	I-QBPX85	1
R1	RES, 47, 5%, 1/2W	I-R5247R0	1
R2	RES, 680, 5%, 1/4W	I-R516800	1
RA	RECTIFIER BRIDGE	I-D-VE28	1
RN1	RES NET: 2K 6 PIN, SIP, COMMON	I-RN750-61-202	1
S1,2	CONNECTOR JACK (450-3388-01-04)	HW-450-3388	2
P1-4	PIN, .040OD X .520L (CONCORD)	HW-10-990-2-04	4
U1	5V REGULATOR-LOW POWER -100MA	I-IC78L05	1
REF	SCHEMATIC	22727	---

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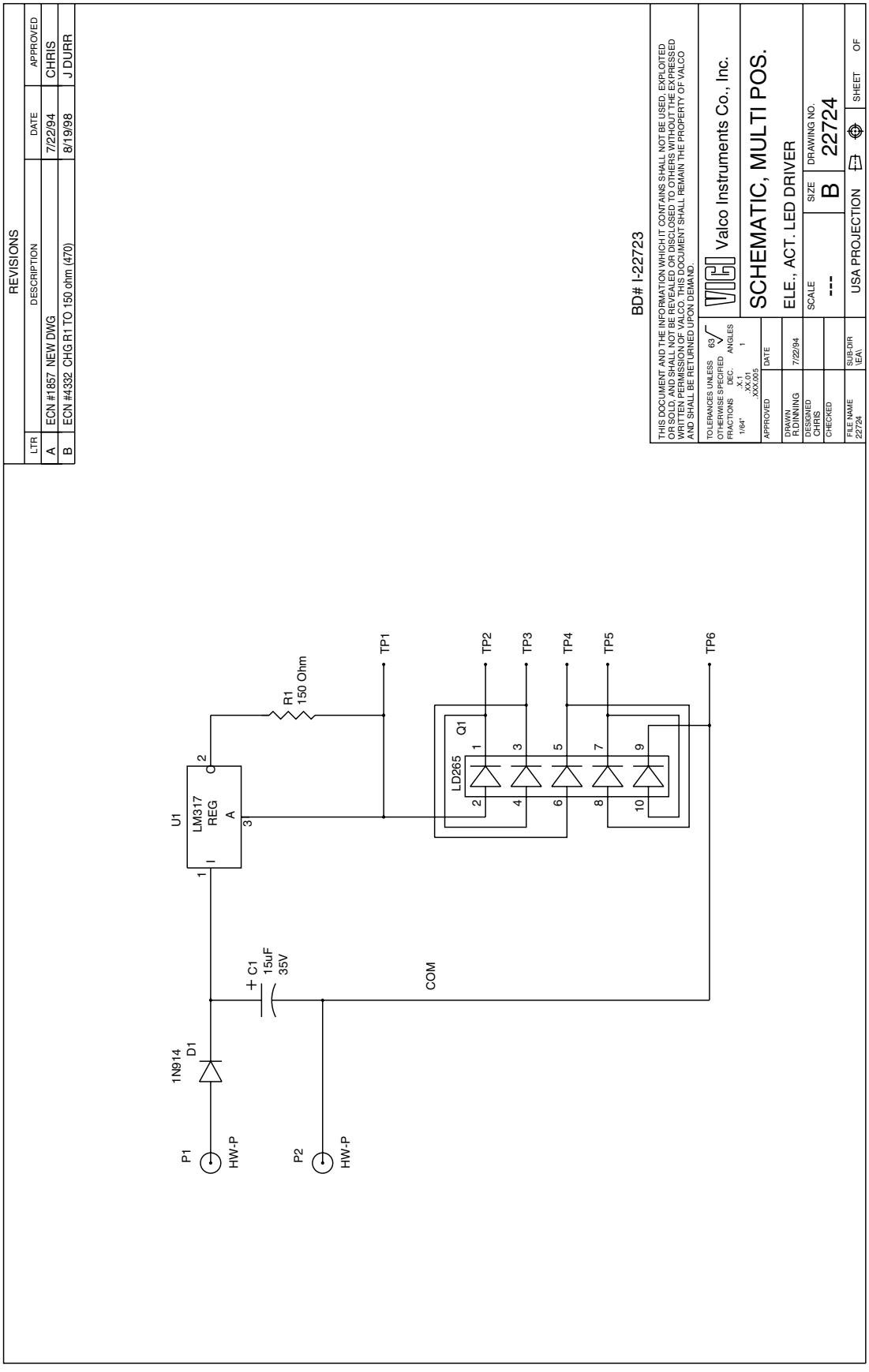
Valco Instruments Co., Inc.

PCB ASSY, ENCODER

MULTI POS. ELE. ACT. I-22726

APPROVED	DATE		
DRAWN CHRIS	4/13/94		
DESIGNED CHRIS		SCALE ---	SIZE B
CHECKED			DRAWING NO. 22726
NEXT ASSY 22834	FILE NAME 22726	SUB-DIR \EA\	USA PROJECTION SHEET OF


REVISIONS
LTR
DESCRIPTION
DATE
APPROVED
A
ECN #1857 NEW DWG
7/22/94
CHRIS
B
ECN #4332 CHG R1 TO 150 ohm (470)
8/19/98
J DURR
BD# I-22723
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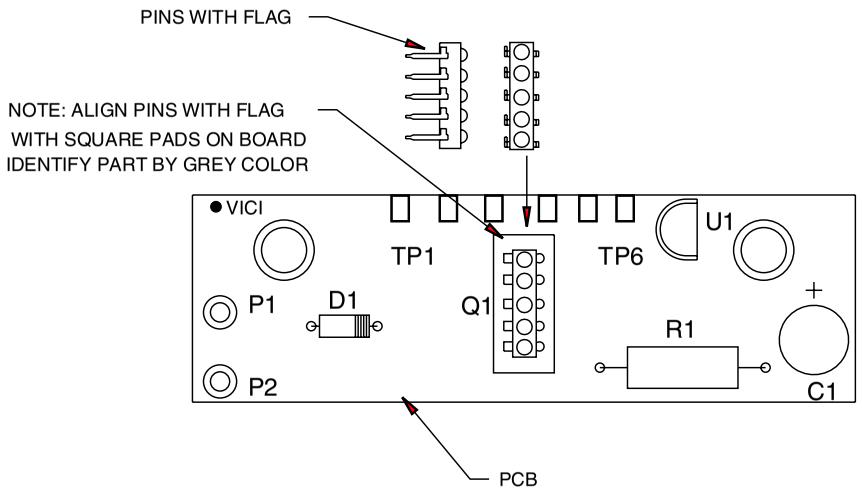
FRACTIONS 1/64"
DEC: .X ±1 .XX ±.01 .XXX ±.005
63
ANGLES 1
APPROVED
DATE
DRAWN R.DINNING
7/22/94
DESIGNED CHRIS
CHECKED
FILE NAME 22724
SUB-DIR \EA\
Valco Instruments Co., Inc.
SCHEMATIC, MULTI POS.
ELE., ACT. LED DRIVER
SCALE ---
SIZE B
DRAWING NO. 22724
USA PROJECTION
SHEET OF
U1
LM317 REG
A
I
1
2
3
R1 150 Ohm
TP1
TP2
TP3
TP4
TP5
TP6
LD265
Q1
1
2
3
4
5
6
7
8
9
10
C1 15uF 35V
COM
D1 1N914
P1 HW-P
P2 HW-P

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	ECN #1857 NEW DWG	5/3/94	CHRIS
B	ECN #4040 CHG R1 TO 90.9 (470)	1/16/98	J DURR
C	ECN #4332 CHG R1 150ohm (90.9)	8/19/98	J DURR



PARTS LIST			
ITEM	DESCRIPTION	VALCO #	QTY
PCB	PCB, LED DRIVE AW 331(B) MULTI ACT ASSY	I-PCB22722	1
C1	CAP, TANTAL, 1OMF 25V	I-CT106-25	1
D1	DIODE, SILICON SIGNAL	I-D1N914	1
Q1	DIODE ARRAY LIGHT-EMITTING	I-QLD265	1
R1	RES: 150 OHM 1%, 1/4W	I-R111500	1
P1,2	PIN, .040OD X .520L (CONCORD)	HW-10-990-2-04	1
U1	VOLTAGE REGULATOR, LOW POWER ADJ. TO-92	I-ICLM317LZ	1
REF	SCHEMATIC	22724	--

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FRACTIONS 1/64" DEC. .X.1 .XX.01 .XXX.005 ANGLES 1
63

Valco Instruments Co., Inc.

PCB ASSY, LED DRIVER

MULTI POS ELE ACT I-22723

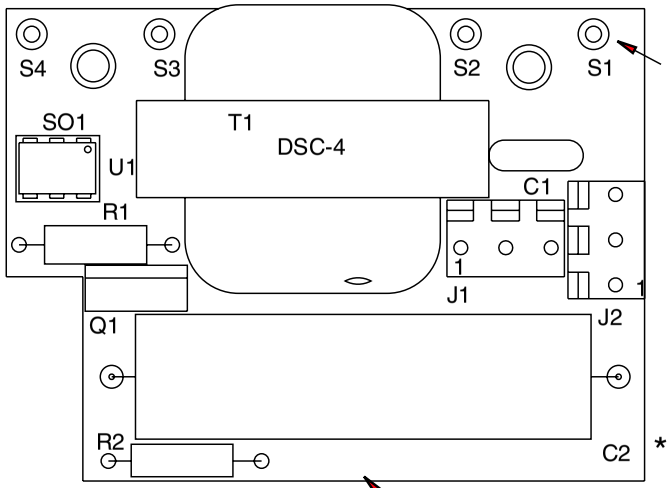
APPROVED	DATE
DRAWN CHRIS	4/13/94
DESIGNED CHRIS	
CHECKED	
FILE NAME 22723	SUB-DIR \EA\

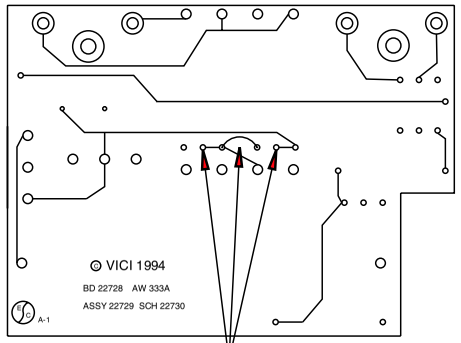
SCALE ---
SIZE B
DRAWING NO. 22723
USA PROJECTION
SHEET OF

NEXT ASSY 22834

DASH SCHEDULE			
VALCO #	VOLTAGE OPT.	BD. OPTIONS	C2 VALCO #
I-22729-01	110V	STANDARD	I-CM106-250
* I-22729-02	220V	SEE NOTES	I-CM335-400

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	ECN #1857 NEW DWG	5/3/94	CHRIS
B	ECN #2832 ADD POLARITY MARK ON TRANSFORMER	10/23/95	J DURR/JANELLE





* NOTE:
FOR 220V OPTION
FROM BOTTOM OF BOARD
DRILL THRU VIAS (2)
JUMPER AS SHOWN

* FOR 220V OPTION

ITEM	DESCRIPTION	VALCO #	QTY
PCB	PCB, TRANSFORMER AW 333 (A) MULTI ACT	I-PCB22728	1
C1	CAP, CERAMIC, .005uF 1KV	I-CC502-1K	1
C2	CAP, MYLAR, 10uF 250V (110V VERSION)	SEE DASH SCH	1
J1,2	CONN 3 PIN W/RAMP MOLEX	I-T26510032	2
Q1	TRIAC 4AMP-600V	I-Q6004L4	1
R1,2	RES, 300, 5%, 1/4W	I-R513000	2
S1-4	CONNECTOR JACK (450-3388-01-04)	HW-450-3388	4
T1	TRANSFORMER 115/230V DSC4-24	I-X-DSC4-24	1
U1	IC, OPTO-TRIAC ZERO CROSSING	I-IC3082	1
SO1	SOCKET, DIP, 6 PIN, LOW PROFILE	I-TDS-6-LP	1
JMP	BUSS WIRE UNINSULATED .025 DIA	I-W-BUSS-1	.5" *
REF	SCHEMATIC	22730	--

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TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 1/64" DEC. .X 1 .XX .01 .XXX .005 ANGLES 1
63

Valco Instruments Co., Inc.

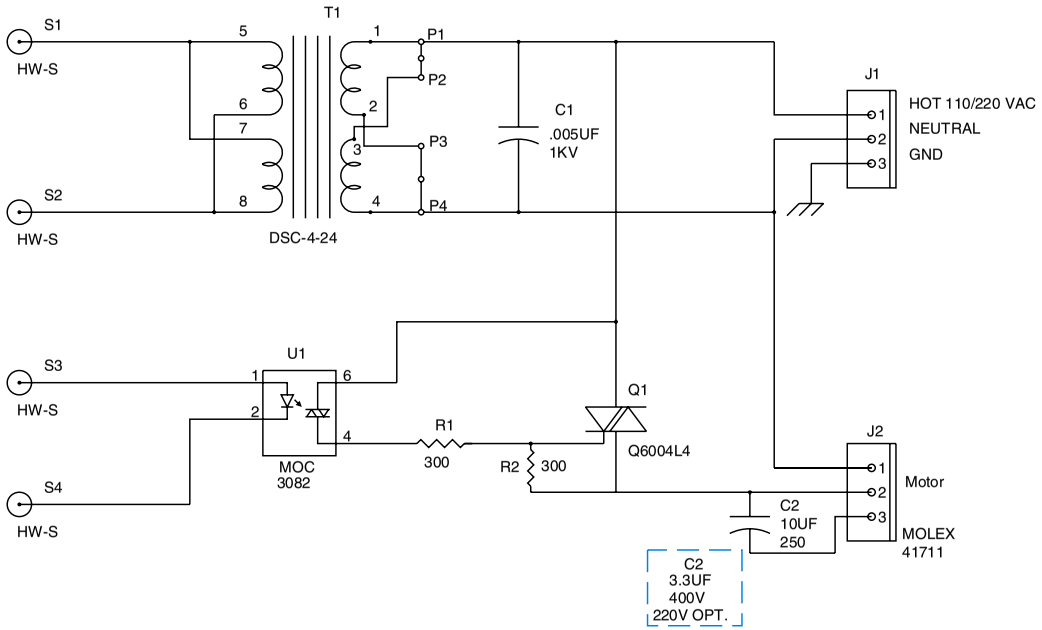
PCB ASSY, TRANSFORMER

MULTI. POS. ELE. ACT. I-22729

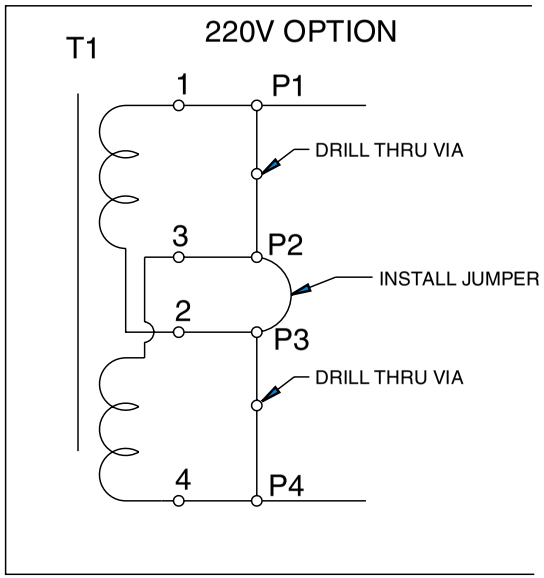
APPROVED	DATE
DRAWN R.DINNING	4/13/94
DESIGNED CHRIS	
CHECKED	
FILE NAME 22729	SUB-DIR \EA\

NEXT ASSY 22834

SCALE ---
SIZE B
DRAWING NO. 22729
USA PROJECTION
SHEET OF



REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	NEW DWG ECN# 1857	7/22/94	CHRIS
B	CHG SCHEM. LAYOUT ECN# 2662	7/25/95	JDURR



NOTE:

WHEN FABRICATED, BOARD IS WIRED FOR 115V THRU VIAS BETWEEN P1 & P2 AND P3 & P4.

FOR 220V OPERATION, DRILL THRU VIAS AND JUMPER P2 TO P3.

BD# I-22729

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TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 1/64" DEC. .X .1 .XX .01 .XXX .005 ANGLES 1
63

Valco Instruments Co., Inc.

SCHEMATIC TRANSFORMER

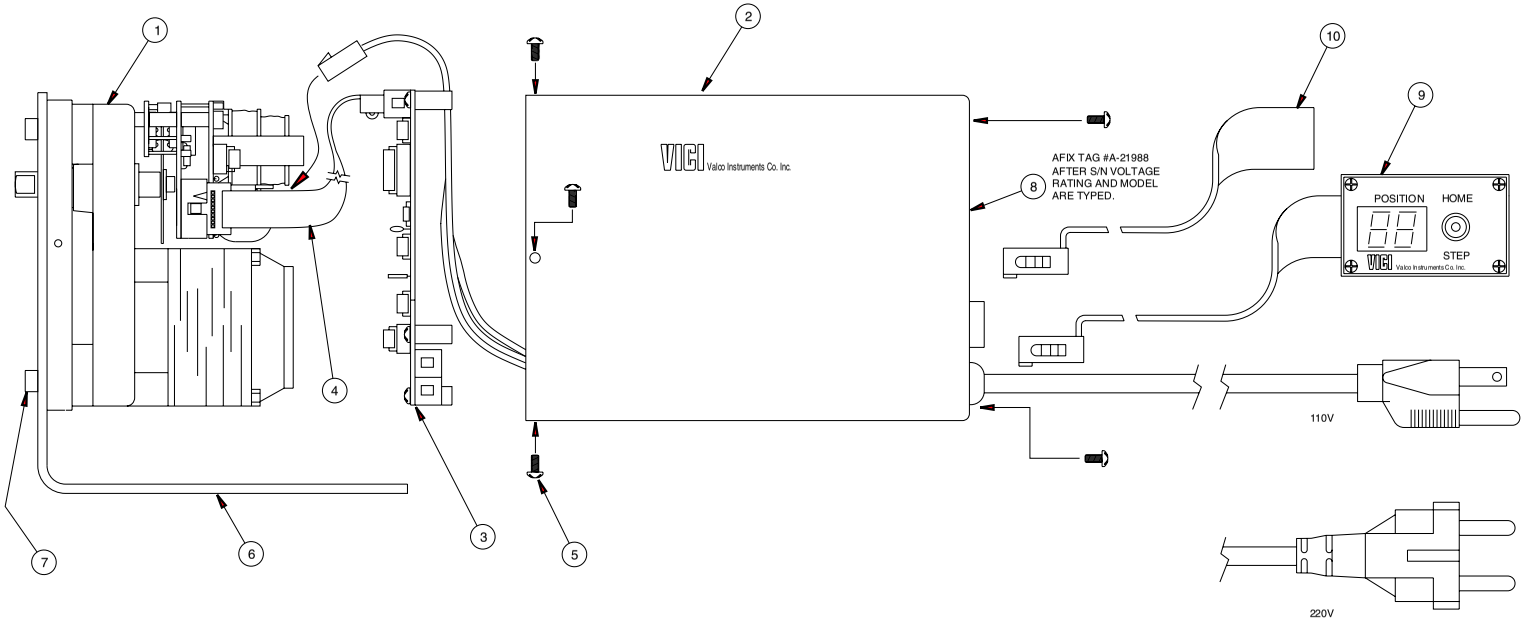
BD. MULTI POS. ELE., ACT.

APPROVED	DATE		
DRAWN R.DINNING	7/22/94		
DESIGNED CHRIS		SCALE	SIZE B / DRAWING NO. 22730
CHECKED			
FILE NAME 22730	SUB-DIR \EA\	USA PROJECTION	SHEET OF

VALCO #	POS.	ITEM 1	ITEM 2
I-22835-04-110	4	I-22834-04-110	I-21803
I-22835-04-220	4	I-22834-04-220	I-21803-220
I-22835-06-110	6	I-22834-06-110	I-21803
I-22835-06-220	6	I-22834-06-220	I-21803-220
I-22835-08-110	8	I-22834-08-110	I-21803
I-22835-08-220	8	I-22834-08-220	I-21803-220
I-22835-10-110	10	I-22834-10-110	I-21803
I-22835-10-220	10	I-22834-10-220	I-21803-220

VALCO #	POS.	ITEM 1	ITEM 2
I-22835-12-110	12	I-22834-12-110	I-21803
I-22835-12-220	12	I-22834-12-220	I-21803-220
I-22835-16-110	16	I-22834-16-110	I-21803
I-22835-16-220	16	I-22834-16-220	I-21803-220
I-22835-4CS-110	4 CS	I-22834-4CS-110	I-21803
I-22835-4CS-220	4 CS	I-22834-4CS-220	I-21803-220
I-22835-6CS-110	6 CS	I-22834-6CS-110	I-21803
I-22835-6CS-220	6 CS	I-22834-6CS-220	I-21803-220

REVISIONS			
LTR	DESCRIPTION	DATE	INITIATED
A	NEW DWG ECN# 2015	7/26/94	JDURR
B	ADD 220V ENC. ASSY. ECN# 2537	05/08/95	JDURR
C	ADD CHANGES FOR GSS ITEMS ECN# 4470	11/03/98	JDURR



PARTS LIST				
	ITEM	DESCRIPTION	VALCO #	QTY
*	1	MOTOR ASSY (C-22834)	SEE DASH SCH.	1
	2	ENCLOSURE ASSY, MULTI POS ELE ACT	SEE DASH SCH.	1
*	3	BD. ASSY, LOGIC MULTI POS ELE ACT	I-22720-01	1
*	4	CABLE ASSY. ENCODER TO LOGIC	I-21487	1
	5	SCREW PLMS: 4-40 X 1/4 LG	HWSC-PL4-4	8
	6	BRACKET FOR MP EA.	I-21486	1
	7	SCREW SHCS: 8-32 X 3/8 LG	HWSC-SC8-6B	4
*	8	TAG, SERIAL FOR ALL ELECT. DEVICES	I-21988	1
	9	CONTROLLER ASSY. MP EA	I-21412	1
	10	INTERFACE CABLE ASSY MP EA (ONLY 1 END)	I-21421-01	1

* I-22835 WITH GSS SUFFIX USE THE APPROPRIATE MOTOR AND ENCLOSURE ASSY'S AND THESE PARTS ONLY AFFIX SERIAL TAG TO FRONT CASTING

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TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 1/64" DEC .X 1 .XX .01 .XXX .005 ANGLES 1
63

Valco Instruments Co., Inc.

ACTUATOR ASSY, MULTI POS ELE. I-22835

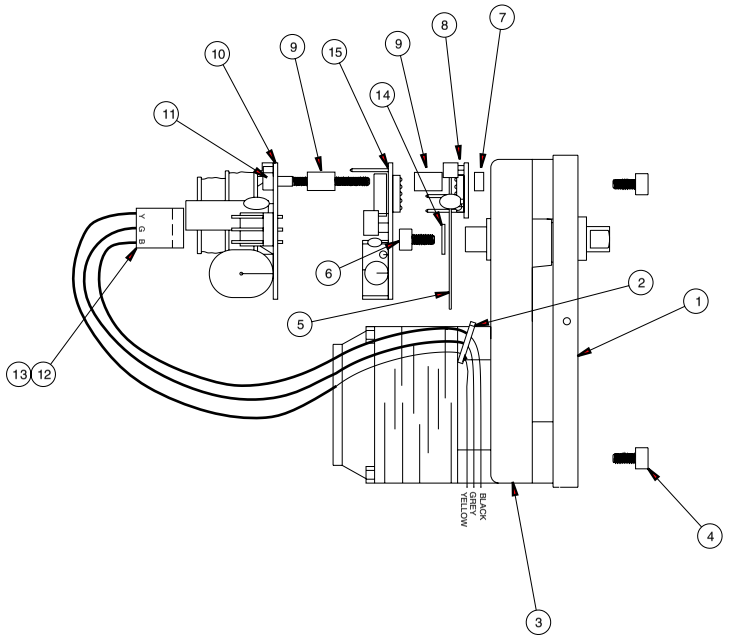
APPROVED	DATE
DRAWN R.DUNNING	7/26/93
DESIGNED	
CHECKED	

SCALE 1:1 | SIZE C | DRAWING NO. 22835

FINAL ASSY | FILE NAME 22835 | SUB-DIR EA | USA PROJECTION | SHEET OF

PARTS LIST			
ITEM	DESCRIPTION	VALCO PART#	QTY.
1	CASTING MODIFIED C-21482	I-21482	1 EA
2	TYWRAP TYTON 1/4 X 4"	HWTYWRAP-2	1 EA
3	MOTOR	SEE DASH	1 EA
4	SCREW, SHCS: 8-32 X 1/2 LG	HWSC-SC8-8B	4 EA
5	ENCODER DISK	SEE DASH	1 EA
6	SCREW, SHCS: 8-32 X 1/4 LG	HWSC-SC8-4B	1 EA
7	SPACER: .25 OD*.17 ID*.125 LG. ALUM.	HWSP-8520	2 EA
8	PCB ASSY, LED DRIVER MULTI POS ELE ACT	I-22723	1 EA
9	SPACER #8 X 3/8"	HWSP-8522	4 EA
10	PCB ASSY, TRANSFORMER MULTI POS ELE ACT	SEE DASH SCH.	1 EA
11	SCREW, SHCS: 8-32 X 1-1/4 LG	HWSC-SC8-20B	2 EA
12	MOLEX CONN. 09-50-3031	I-T09503031	1 EA
13	MOLEX TERM. 08-50-0106 (NOT SHOWN)	I-T08500106	3 EA
14	WASHER, FLAT #8 .175*.375*.030	HWW-F#8	1 EA
15	PCB ASSY, ENCODER MULTI POS ELE ACT	I-22726	1 EA

REVISIONS			
LTR	DESCRIPTION	DATE	INITIATED
A	ECN #2015 NEW DWG	7/26/94	J DURR



DASH SCHEDULE			
VALCO #	DISK (ITEM 5)	MOTOR (ITEM 3)	BOARD (ITEM 10)
I-22834-04-110	I-21536	I-21481-110	I-22729-01
I-22834-04-220	I-21536	I-21481-220	I-22729-02
I-22834-06-110	I-21537	I-21481-110	I-22729-01
I-22834-06-220	I-21537	I-21481-220	I-22729-02
I-22834-08-110	I-21538	I-21481-110	I-22729-01
I-22834-08-220	I-21538	I-21481-220	I-22729-02
I-22834-10-110	I-21539	I-21481-110	I-22729-01
I-22834-10-220	I-21539	I-21481-220	I-22729-02
I-22834-12-110	I-21540	I-21481-110	I-22729-01
I-22834-12-220	I-21540	I-21481-220	I-22729-02
I-22834-16-110	I-21541	I-21481-110	I-22729-01
I-22834-16-220	I-21541	I-21481-220	I-22729-02
I-22834-6CS-110	I-21542	I-21481-110	I-22729-01
I-22834-6CS-220	I-21542	I-21481-220	I-22729-02
I-22834-4CS-110	I-21543	I-21481-110	I-22729-01
I-22834-4CS-220	I-21543	I-21481-220	I-22729-02

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TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 1/64" DEC. X .1 XX .01 XXX .005 ANGLES 1°
63 √

VICI Valco Instruments Co., Inc.

MOTOR ASSY MULTI POS.
I-22834
ELEC. ACTUATOR

APPROVED	DATE		
DRAWN R.DINNING	7/26/93		
DESIGNED		SCALE ----	SIZE C
CHECKED			DRAWING NO. 22834
FILE NAME 22834	SUB-DIR EA	USA PROJECTION	SHEET OF

NEXT ASSY
22835

Warranty

This Limited Warranty gives the Buyer specific legal rights, and a Buyer may also have other rights that vary from state to state.

For a period of 365 calendar days from the date of shipment, Valco Instruments Company, Inc. (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or nonconforming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at Seller's option, the repayment of the price.

SELLER EXCLUDES AND DISCLAIMS ANY LIABILITY FOR LOST PROFITS, PERSONAL INJURY, INTERRUPTION OF SERVICE, OR FOR CONSEQUENTIAL INCIDENTAL OR SPECIAL DAMAGES ARISING OUT OF, RESULTING FROM, OR RELATING IN ANY MANNER TO THESE GOODS.

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is VOID when repairs are performed by a nonauthorized service center or representative. For information about authorized service centers or representatives, call or write Customer Repairs, Valco Instruments Company, Inc, P.O. Box 55603, Houston, Texas 77255. ph(713) 688-9345 At Seller's option, repairs or replacements will be made on site or at the factory. If repairs or replacements are to be made at the factory, Buyer shall return the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed in accordance with the laws of the State of Texas.

THE WARRANTIES CONTAINED IN THIS AGREEMENT ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

This Limited Warranty supercedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.